E7.2-10.3.36
CR-129650

Type II PROGRESS REPORT

June 19, 1972 - December 19, 1972

Crop Identification and Acreage Measurement Utilizing ERTS IMAGERY (013)

Principle Investigator

Donald H. Von Steen AG 328

TABLE OF CONTENTS

INTRODUCTION

The Statistical Reporting Service (SRS) is interested in the ERTS Program as a possible tool for estimating U.S. crop acreage. Its Research Division has the responsibility of investigating new methods of data collection and utilization to improve agricultural statistics. SRS researchers have for some time been concerned with the development of the technology and methodology for making automated crop surveys from aircraft. The opportunity to study the potential of satellite imagery is a logical extension of the present programs involving the use of remote sensing for crop estimation.

PERSONNEL AND EQUIPMENT

With the contract agreement of June 19, 1972, the Research and Development Branch of the Research Division fixed the personnel and equipment for the ERTS project under the direction of principle investigator Donald Von Steen. Paul Hopkins, Carol Claggett and Fred Warren are the EDP specialists. Harold Huddleston, William Wigton, Ronald Bosecker, and John Ridgely are the mathematical statisticians who will work on the project. The address and telephone number have changed since the last progress report to South Building Room 4814 and phone 447-3131.

Photo interpretation is done on a Richards MIM-3 light table equipped with a Bausch and Lomb microscope. A request for a scanning microdensitometer which reads optical densities directly from photographs and records them on magnetic tape has been submitted and this equipment should be available in May 1973. An IBM Model 65 computer and remote access terminal (RAX) are available for processing magnetic tapes.

In addition, the personnel and equipment of the cooperating State Statistical Offices in Missouri, Kansas, South Dakota, and Idaho have assisted in the collection of ground truth data for the test sites.

GROUND TRUTH

The basic data collection work on the ground was done prior to the ERTS-A launch as part of our normal June Enumerative Survey (JES) crop and livestock estimating program. Data from the sample land area segments falling within the designated research areas was taken from the survey summary sheets to form the basis of the ground truth information concerning the test sites. There are 52 segments in Missouri, 48 in Kansas, 50 in South Dakota, and 71 segments in Idaho.

Crop species, acres, and condition were recorded for each field in the test segments and for additional randomly selected training fields within the same

SRS crop reporting districts as the test segments. Surveys to update this information were made during August 7-11, September 11-15, and October 10-13 to associate with satellite coverage in those months.

Computer processing of the update information is scheduled to begin soon. Comparison between crop and acreage determinations from ERTS and aircraft photography and the ground truth data will be possible immediately upon the receipt of data from the discriminant analysis.

The ground truth collection procedures and a preliminary summary of early results are provided in the Type I reports of August 19 and October 19, 1972.

PHOTOGRAPHY AND DIGITAL TAPES

The standing order for ERTS imagery over the test areas in Missouri, Kansas, South Dakota, and Idaho calls for 70mm positive and negative transparencies and bulk digital tape (all available channels) with less than 50 percent cloud cover. Anticipated data requirement as listed in the investigator's profile is a precision color composite 9.5" photograph. These have been ordered on Data Request forms but none have been received. Further requests through the Technical Monitor, Arthur W. Fihelly are being made for bulk 9.5" positive transparencies of the test sites and available precision digital tapes. Enlargements of selected photographs are being ordered through the ASCS photo lab in Salt Lake City, Utah.

The 9.5" photographs are needed for locating the test segments which vary from .5 to several miles square. If the standing order were to be remade for the three month primary survey period (August, September, October) it would consist of a band 5 bulk black and white 9.5" positive transparency and a 9 track bulk digital tape (all bands) for every image regardless of cloud cover. The anticipated data requirement would be a 9.5" precision color composite and the 9 tract precision digital tape.

The tapes and photographs which have been received are listed in Tables 1 through 4 by State. The dates associated with each image indicate a one month lag between the scene data and receipts of the photography and about two months until receipt of the digital tapes. This has not been a serious drawback to the research project since work on implementing a software package to locate and extract data for our test sites has continued with the earliest tapes received. However, to actively use ERTS coverage in the regular forecasting and estimating program, the turn-around time would have to be less.

In addition to the satellite coverage, there is high altitude aerial photography of some segments available. Randomly selected flight lines across the test districts were photographed by NASA and the South Dakota Remote Sensing Institute. The segments and additional training sites which were photographed in Missouri, Kansas, and South Dakota are shown in Tables 5, 6, and 7. Aerial photography of Idaho was just recently received and has not yet been fully interpreted.

The film from the aircraft will be scanned by the microdensitometer and the optical density readings recorded on magnetic tape. This digitized data will then be classified similar to the classification of the ERTS data on the NASA tapes.

Table 1

MISSOURI

ERTS IMAGERY - Photos and Tapes

Further Request	I.D. No.	Center Point Coordinate	Scene Date	Photo Rec'd	Tape Rec'd	Notes
✓	1034-16052	B37-22/W88-44	8/26	10/6	11/17/(B)	MSS
✓	1034-16055	N35-56/W89-12	8/26	10/6	11/22(B)(P)12/19	
✓	1035-16112	N36-34/W90-30	8/27	11/9		
	1052-16052		9/13		11/15(B)	
✓	1070-16052	N37-31/W88-42	10/1	11/1		
✓	1070-16055	N36-06/W89-09	10/1	11/1		
✓	1071-16111	N37-34/W09-05	10/2	11/1		
✓	1071-16113	N36-08/W90-33	10/2	11/1		
✓	1089-16113	N37-25/W90-14	10/20	12/6		
✓	1089-16120	N36-01/W90-42	10/20	12/6		

Table 2

KANSAS

ERTS IMAGERY - Photos and Tapes

Further Request	I.D. No.	Center Point Coordinate	Scene Date	Photo Rec'd	Tape Rec'd	Notes
	1005-16454	N36-24/W99-06	7/28	8/21		RBV
✓	1007-16563	N38-50/W101-12	7/30	8/31	10/20	RBV
	1008-17021	N38-53/W102-38	7/31	8/31		RBV
✓	1023-16454	-	8/15	-	11/15(B)	
	1025-16565	N37-60/W101-29	8/17	10/5	12/4(P)	
✓	1025-16571	N36-34/W101-57	8/17	10/5	11/15(B)	
	1026-17024	N37-45/W103-03	8/18	10/2		
✓	1043-16570	N37-22/W101-45	9/4	10/6	11/15(B)	
	1044-17022	N38-47/W102-42	9/5	11/1		
✓	1060-16505	N38-48/W99-47	9/21	11/3	11/22(B)	
✓	1060-16512	N37-23/W100-15	9/21	11/3		
✓	1061-16564	N38-48/W101-12	9/22	10/25		
✓	1061-16570	N37-23/W101-41	9/22	10/25		
✓	1095-16460	N37-22/W98-52	10/26	11/22	11/22(B)	
	1114-16502	-	11/14	-	12/19(B)	
	1116-17031	-	11/16	-	12/19(B)	

Table 3

SOUTH DAKOTA

ERTS IMAGERY - Photos and Tapes

Further Request	I.D. No.	Center Point Coordinate	Scene Date	Photo Rec'd	Tape Rec'd	Notes
	1005-16431	N44-56/W96-07	7/28	8/21		
	1007-16545	N44-31/W99-09	7/30	8/31		
	1023-16440	-	8/15	-	11/16(B)	
✓	1024-16491	-	8/16	-	11/9(B)	
	1025-16545	N44-60/W98-58	8/17	9/22		
✓	1025-16551	N43-34/W99-31	8/17	9/22		
✓	1041-16433	N44-31/W96-21	9/2	10/19	11/16(B)(P)12/19	
✓	1041-16435	N43-05/W96-53	9/2	10/19	11/9(B)	
	1042-16491	-	9/3	-	11/9(B)	
✓	1043-16500	N44-29/W99-21	9/4	10/12	11/17(B)	
✓	1060-16491	N44-30/W97-45	9/21	11/2	11/9(B)	
✓	1060-16494	N43-04/W98-17	9/21	11/2	11/15(B)	
	1076-16382	N43-13/W95-21	10/7	11/9		
✓	1077-16440	N43-09/W96-46	10/8	11/17		
	1077-16434	N44-35/W96-13	10/8	11/17		
✓	1078-16492	N44-38/W97-40	10/9	11/8	11/9(B)	
	1079-16551	N44-35/W99-06	10/10	11/8	11/16(B)	
	1095-16440	N44-29/W96-20	10/26	11/22	11/20(B)	
✓	1095-16442	N43-04/W96-52	10/26	11/22	11/20(B)	
	1097-16553	N44-26/W-9-14	10/28	11/20	11/22(B)	

Table 4

IDAHO

ERTS IMAGERY - Photos and Tapes

Further Request	I.D. No.	Center Point Coordinate	Scene Date	Photo Rec'd	Tape Rec'd	Notes
	1018-17585	-	8/10	-	11/17(B)	
	1018-17583	-	8/10	-	11/8(B)	
✓	1036-17583	N43-04/W115-33	8/28	10/6	11/8(B)	
	1036-17585	N41-39/W116-05	8/28	10/6		
✓	1034-17470	N43-03/W112-41	8/26	10/20	11/22(B)	
✓	1034-17473	N41-38/W113-12	8/26	10/20	11/9(B)(P)12/19	
✓	1035-16525	N43-02/W114-07	8/27	10/20	11/15(B)	
✓	1035-17531	N41-36/W114-39	8/27	10/20	11/8(B)(P)12/19	
	1036-17583	-	8/28	-	12/19(B)	
✓	1052-17470	N43-06W112-38	9/13	11/3	11/8(B)	
✓	1052-17472	N41-41/W113-10	9/13	11/3	11/8(B)	
✓	1053-17524	N43-06/W114-03	9/14	10/19	11/8(B)(P)12/19	
✓	1053-17531	N41-42/W114-35	9/14	10/19	11/8(B)(P)12/19	
✓	1054-17583	N43-04/W115-28	9/15	10/18	11/9(B)(P)12/19	
✓	1054-17585	N41-38/W116-00	9/15	10/18	11/9(B)(P)12/19	
	1070-17470	N43-13/W112-32	10/1	11/22		
✓	1071-17524	N41-51/W114-29	10/2	11/6	11/1(B)	
✓	1071-17531	N43-11/W115-24	10/2	11/6	12/8(B)	
✓	1072-17583	N43-11/W115-24	10/3	11/9		
	1072-17585	N41-46/W115-57	10/3	11/9		
	1106-17474	-	11/6	-	12/6(B)	
	1106-17481	-	11/6	-	12/6(B)	
✓	1107-17532	N43-01/W114-09	11/7	12/6	12/8(B)	
	1107-17535	N41-36/W114-41	11/7	12/6	12/8(B)	

Table 5

ERTS PROJECT

MISSOURI AERIAL PHOTOGRAPHY

Mission; Date Camera, Roll Segments	208; 8/28/72 RC-8; 33 Frame No.	 ZEISS; 34 Frame No.	211; 9/19/72 RC-8; 42 Frame No.	 ZEISS; 44 Frame No.	S.D.R.S.I.: 8/19-20/72 4 filters Frame No.
F.L. 2					
4418	29	--	99	--	38 & 39
4420	31	55	98	25	42
F.L. 8					
4411	05	7	127		3
3412	07	--	124		28 & 29
1413	07	12	124	78	19 - 25
4414	04	6	128	84	6 & 7
1435	13	22	120	69	9
3436	10	17	122	73	2
4458	11	--	121		
4460	08	16	123	76	32 & 33
Extras					
3416	28	--	--		
4417	30	53	98		
4419	29	--	99		
3432	15	--	118		
4434	12	--	120		
4437	10	--	123		
Training					
2A1	31	55	97	23	44 & 45
2A2	30	55	98	24	47 - 53
2B	29	--	100		29 & 30
2C	29	--	99		33
2D	28	49	100		25 & 26
8A	05	6	128	85	11 & 12
8B	07	12	125	79	14 & 15
8C	11	18	121	72	37 & 38
8D	11	19	121	72	5 & 6
8E	12	--	120		41 & 43 20 & 21
8F	15	26	118	64	15 & 16

Table 6

ERTS PROJECT

HIGH ALTITUDE AERIAL PHOTOGRAPHY

KANSAS

Mission; Date	208; 8/18/72		211; 9/17/72		S.D.R.S.I.: 8/12-14/72
Camera, Roll	RC-8; 1	ZEISS; 3	RC-8; 33	ZEISS: 35	4° Filters of 4 Rolls Each
Segments	Frame No.	Frame No.	Frame No.	Frame No.	Frame No.
F.L. 3					
4087	41	--	19	--	B26 - 31
1089	43	85	17	29 & 271	-
4101	48	95	13	20 & 280	A27 - 30
3106	37	72	23	259	B 1 - 5
4107Noc	34	66	27	--	C40
1113	53	107	07	08 & 291	A53 - 56
4114	50	100	10	16 & 285	A34 - 38
1115	40	79	21	265	B12 - 15
3116	41	81	19	268	B22
F.L. 10					
4120	14	26	--	--	D12 - 16
3122	24	48	--	--	C23 - 26
4124	18	35	--	--	C 1 - 8
1125Noc	Noc	--	--	--	-
4130	22	43	--	--	C17 - 19
Extra					
4088	44	--	17	--	-
Training					
3-A	50	101	10	14 & 286	A42
3-B	36	70	25	45	C36
3-C	37	72	24	260	-
3-D	40	81	20	266	B 7 & 8
3-E	40	81	20	267	B18
3-F	42	83	19	32 & 269	B39 - 51
3-G	42	83	19	32 & 269	B57 - 64
3-H	43	--	17	--	B36
3-I	43	85	17	30 & 272	A 3
3-J	43	87	17	28 & 273	A 8
3-L	46	--	14	--	A15
3-M	47	--	13	--	A18
3-P	54	109	06	07 & 293	A49 & 50
10-A	24	--	--	--	C32
10-E	9	17	--	--	D 2 - 5

Note: RC-8 and ZEISS coverage of segments 1113, 4114, and 3A are also available from Mission 217 dated 10/24/72.

Table 7

ERTS PROJECT

SOUTH DAKOTA AERIAL PHOTOGRAPHY

Mission; Date Camera, Roll Segments	211; 9/22/72 RC-8; 54 Frame No.	ZEISS; 56 Frame No.	211; 9/14/72 RC-8; 17 Frame No.	ZEISS; 19 Frame No.	S.D.R.S.I.: 8/27/72 4 filters and 4 rolls Frame No.
F.L. 3				None	
3196	2934	70			46
4197	2932	66			54
1199	2934	71			50
4210	2930	62			5 & 6
F.L. 5				None	
1213	2908	18	188		26
1223	2912	27	184		14
3236	2906	14	191		35
4237	2906	--	191		32
4240	2915	--	181		8
Extra				None	
1195	2934	--			
4198	2933	69			
4208	2928	--			
4211	2928	--			
3212	2909	--	187		
4214	2908	20	188		
3222	2913	--	--		
4224	2912	27	184		22 & 23
1235	2906	--	190		
1239	2918	--	179		
4241	2918	39	179		
Training				None	
3-A3	2930	62			1
3-B-9	2933	68			53
3-C-3	2935	--			44
3-C-5	2935	72			48
3-C-6	2935	--			41
3-D-8	2935	74			38
5-C-2	2913	27	184		12
5-C-3	2913	29	184		20
5-C-4	2913	29	--		16
5-E-2	2908	17	189		29

DATA PROCESSING

Implementation of a program to locate and print the digitized data for the test sites is the biggest problem at present. The original specifications had requested precision tapes so early EDP work was directed toward the use of the precision format. This was subsequently changed to bulk tapes on the standing order necessitating new preparation for utilizing these tapes. It appears that the bulk tapes may be more desirable for this project because of better resolution. However, if possible, results from the use of both tapes will be summarized for comparison.

In addition to the in-house development of the capability for utilizing tapes, there has been an effort to make use of the prior work done by others in this field. Classification programs were obtained from Purdue (LARSYS), Penn State (Penn State Classifier) and North Carolina State University (Statistical Analysis System). The SAS package from N. C. State was the easiest to implement and its discriminant analysis program has been used to classify densitometer readings on aerial photography successfully. The Purdue LARSYS program and the Penn State Classifier should provide more utility but are difficult to implement. Once the search and retrieval programs are tested and the classifier is operational, the ERTS sensor readings will be investigated with respect to ground truth.

DATA ANALYSIS

A detailed data analysis report is being submitted under separate cover as specified in Phase II (c) of Paragraph 3 in the Memorandum of Understanding.

Crop type and acreage information from the classification of aircraft and ERTS imagery will be compared and tested against the ground truth data. The analysis is designed to answer the following questions:

1. What is the frequency of correctly identifying each type of crop with one discriminate function?
2. Within what confidence interval are we able to determine the acreage of various crops in a segment from ERTS and aircraft imagery?
3. How much difference is there between crop acreages estimated from the three data sources? What is the correlation?
4. Is there a significant difference between States in the misclassification of crops?
5. Is there a difference in the month to month performance of our discrimination and estimation models?
6. What impact do clouds have on remote sensing estimation?
7. How does the turn-around time and the cost of using the satellite and aircraft for data collection compare with ground enumeration?
8. Can different sources of data be combined to provide reliable crop estimates at lower cost than any one procedure alone?

Development of the necessary procedures, investigation of the data, and interpretation of the results to answer these questions will determine the applicability of ERTS to SRS needs. Progress to this time has been in the area of data collection (ground, aircraft, and satellite) and the development of techniques to summarize the data. The next phase is to use the data for testing hypotheses.